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PURE WATER
AND
HOW TO OBTAIN IT

THE PUBLIC HEALTH LABORATORIES

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PURE WATER AND HOW TO OBTAIN IT

Pure water and pure air are absolutely essential to the maintenance of perfect health. Yet it is safe to say that more than half of our population ar breathing impure air most of the time and an equal number are drinking unwholesome, or questionable, water every day in the year. The latter statement applies particularly to North Dakota. This is in part due to difficulty in procuring good drinking water, but in a far greater meausre to lack of information pertaining to water supplies. It is quite generally known that water not infrequently becomes the carrier of the poison of typhoid fever and cholera, but most people do not understand how this poison gets into the water, and how it may safely be kept from entering it. The purpose of this bulletin is, therefore, to explain in every-day language what is meant by pure drinking water and how it may be obtained Also what is meant by polluted or poisoned water, how this pollution is brought about and how it can be guarded against.

Normal Water and Polluted Water

For the sake of clearness the State Board of Health of Massachusetts has divided all waters into two classes, viz" normal waters and polluted waters. Normal waters are natural waters occuring in nature under various conditions but not containing any offal from human or animal bodies, nor any factory wastes or kitchen wastes. Polluted waters are those that have been befouled with human or animal offal, kitchen wastes or factory wastes.

Absolutely pure water ls not known in nature, but all normal waters contain some foreign ingredients. The nature of these depends on the character of the soil through which, or over which, the water has passed or come in contact. These foreign ingredients do not necessarily detract from the wholesomeness of the water, but, on the other hand, they may render it unfit for drinking purposes or for domestic use. For instance, surface water having stood in contact with peaty soil often acquires a very disagreeable odor and taste, making its use objectionable. Ground-water may have passed through soil containing much alkali and in so doing have dissolved enough of the alkali to render it unsuitable for drinking purposes. In other localities the ground-water takes up so much of the salts of lime and magnesia from the soil that it is too hard for domestic uses, and undesirable or harmful when used as drinking water.

What Constitutes Pure Drinking Water?

Pure drinking water must first of all be free from all kinds of disease-producing bacteria. That does not mean that it must be free from all bacteria, because nearly every normal water contains more or less of the harmless bacteria.

It must not contain even traces of domestic sewage, because sewage always contains the discharges from the kidneys and bowels, washings from skin, pus sputum, etc., it becomes perfectly evident that it is a highly dangerous and objectionable substance to get into drinking water.

Pure water must be free from disagreeable odors and tastes, and should be perfectly clear and sparking. Turbid water is to be regarded with suspicion because it is likely to be polluted with surface washings and contain all manner of filth and dangerous bacteria. We must always bear in mind however, that turbid water may at times be safe and that perfectly clear water may be dangerous.

Lastly, pure water must not contain more than traces of putrescible organic matter, and it should not be too highly impregnated with mineral salts. If it contains too much of the salts of lime and magnesia it is too hard for domestic use and is not suitable for drinking purposes.

Classification of Waters.

For most practical purposes waters may be grouped in

(a) Rain and snow water

(b) Ground-water (wells and springs)

Rain and snow water.

Rain and snow waters are really distilled water and under certain conditions are the purest natural waters obtainable. We must remember, however, that these waters may became polluted in the process of collection and storing. The roof of the house or barn may be in a filthy condition from bird droppings and other filth and dust blown on it by the wind. If this filth is not gotten rid of by allowing the first runnings, at the beginning of a rain, to go to waste, our cistern will soon be very filthy and the water in it unwholesome. If this precaution is taken, rain and snow water may be stored in a sanitary condition, provided the cistern is properly protected at the top against surface washings.

Ground-Waters.

By ground-waters we mean those that have trickled down through the soil for varying depths and are then brought back to the surface, either by nature herself (springs) or by man (wells). The greater the depth to which the water has trickled through the soil, the greater is the likelyhood that it will be heavily charged with mineral salts. Water coming from the deep wells is, however, less likely to contain harmful bacteria and organic filth derived from privies, cess-pools, barnyyards, etc.

Wells.

Wells may be either dug, bored or "driven," and it is customary to speak of shallow wells, deep wells and artesian wells. In many parts of North Dakota shallow wells are practically the only source of domestic water supplies. This applies not only to the rural districts but also to most of the villages and to many of the larger cities. The water in these wells is derived indirectly from rain and snow. When it reaches the ground it seeps through the porous soil until it reaches rock or a compact, impervious layer of clay. The soil immediately above this impervious layer is saturated with water, and a hole dug into it soon fills with water. A well cannot have a constant supply if it does not reach down into this saturated layer. If the porous soil through which the water passes contains alkalies and other soluble mineral salts some of these will be dissolved in the water. If the salts of magnesia and lime are present (as they nearly always are in North Dakota soil) the water is hard, that is, is does not give a lather with soap until all of these salts have been precipitated by adding an excess of soap. The curd which soap forms in these waters is decomposed soap, which is lost, so far as obtaining any benefit from it in the process of washing is concerned. The use of very hard water for household purposes results, therefore, in a great waste of soap.

Other mineral salts that are commonly found in groundwaters of North Dakota are the alkalies (carbonates of soda potash), common salt and Glauber's salt (sulphate of soda). If these mineral salts are present in large amounts the water is undesirable for constant use. In North Dakota it is not uncommon to find water in deep wells which contains as high as 200 grains or more of mineral matter to the gallon. This is much too high for water for constant use.

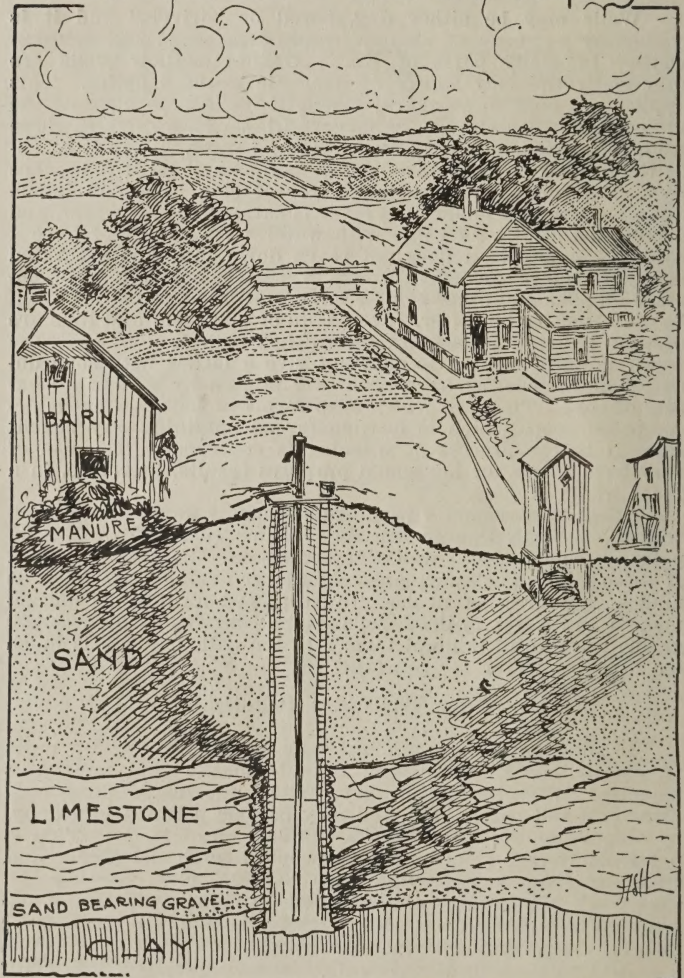
How Wells Are Polluted.

In addition to these mineral salts water from shallow wells frequently contains decaying organic matter and dangerous bacteria. When the well is very shallow, the surroundings very filthy and soil porous, the well may become polluted indirectly, by seepage of the filth through the soil (see Fig. 1). This is particularly true in cities where people live close together and wells are likely to be situated too close to privy or cess-pools, Cess-pools and privies should never be tolerated within one hundred feet of a well, unless the privy is properly constructed and is kept clean by systematic emptying.

Although shallow wells may become polluted indirectly by seepage of the filth and bacteria through the soil (Fig. 1), by

EXPOSED!

The Old Farm Well — A Sink of Iniquity



PERHAPS THIS IS THE SECRET OF THAT "FINE MINERAL FLAVOR" YOU NOTICE IN THE WELL WATER.

far the commonest way is by direct entrance of the polluting material at the top. Figure 2 shows this more clearly than words can tell. If the casing is poorly constructed and leaks, and the well is not provided with a water-tight and dust-proof cover, all manner of filth will find its way into it. The danger of this is greatest in times of heavy rain, when surface washings may run directly into the well.

It is a common sight in North Dakota to see a well with a wooden casing in which there are broken boards, and cracks between the boards. In many instances clay soil has not been tamped in firmly against the boards, leaving an open space between them and the ground for water and filth (containing bacteria) to enter. The covering frequently consists of loose planks with large cracks between. It is impossible for a person with dirty shoes to approach such a well without in some measure polluting it. Many farmers scrape their dirty boots on the well cover and the dirt which is there deposited is sure to be washed into the well when water is spilled on the cover, and when it rains. If some of this filth contains typhoid germs they are sure to get into the water and make it a deadly poison to those who drink it.

The soil around the well also becomes more or less covered with filth and bacteria, and in case of heavy rains those are washed directly into the well. When the well is properly protected at the top, surface washings cannot get into it directly. If the water from the surface washings has to seep through the soil before it can get into the well, it is almost sure to be sufficiently purified to be safe.

How Wells Should Be Protected

A well should be finished with a water-tight casing made of brick or concrete blocks laid in cement, as shown in Fig. 3. This incasement should extend as far down into the well as possible, and the space between it and the ground should be filled in with well-tamped clay soil. The incasement should project about eighteen inches above the surface, and the ground around it should be covered with a thick shield of concrete, or brick laid in cement. The junction between the shield and the projecting incasement should be made water-tight with cement.

A strong tight-fitting cover should always be placed over the top. When possible this cover should be made of cement. When of boards it should be made of sound tongue and groove flooring well driven together. Upon this floor should be placed a second one, at right angles to the first and made of the same kind of material. The floor should fit tightly on the casing so as not to leave a space for frogs, toads and mice to crawl in.

A good pump should be set into the floor, if it is possible to use a pump. It should be firmly fastened to the floor and finished with a flashing or tin to prevent the water washing back into the well from the floor. Where it is impossible to use a pump, a small enclosed well house should be built over the well, which should be provided with a well bucket with an automatic tippinv device. This obviates the necessity of touching the bucket with unclean hands by those using the well.

It is not necessary to make provisions for ventilation of the well, as the water keeps better when not exposed to light and air.

Driven Wells and Bored Wells

Driven wells, also called sand point wells, are sometimes very satisfactory and easy of construction. In soft soil where there is no rock the point is easily driven down to the proper depth. A driven well should be at least twenty-five feet deep. If the well has to be sunk deeper than seventy-five to one hundred feet, it may be necessary to drill a hole before the pipe can be let down. Both the driven wells and the bored wells are less likely to be polluted by surface washings than are shallow open wells. The casing for these wells should preferably be made of cast iron pipe with tight-fitting joints. There should be no open space left between the tubing and the ground, as this permits polluted water from the surface to work its way down into the well without being filtered and purified by the soil. The surroundings of the well should be kept clean and should be turfed. A trough should be provided for carrying off the excess of water that is pumped.

The large bored wells provided with a casing made of sewer pipe are as much exposed to surface pollution as are the shallow dug wells. The joints in this casing should be made perfectly tight and the pipe should project about eihgteen niches above the ground. A pump should be placed into such a well and the top should be tightly covered. The ground around should be protected with a concrete shield as in the case of other shallow wells.

We have frequently seen wells of this kind that were entirely unprotected at the top. In many cases the water is raised up out of the well by means of a tall narrow pail, provided with a very ingenious valve-like device in the bottom for filling. This valve usually leaks so that part of the water runs back into the well while the pail is being pulled up, and in so doing washes more or less dirt and bacteria down into the well. The pail is frequently tied to the end of a rope which lies on the ground. When not in use both the pail and the rope usually lie on the ground beside the well where they are sure to be contaminated with bacteria and filth. The unsanitary condition of such a well is too obvious to demand further comment.

The mineral salts that may be found in bored and driven wells are the same as those already discussed under the heading of dug wells. The deeper the well is, the greater is the likelihood that the water is heavily charged with mineral matter.

Artesian Wells

Artesian wells need not be considered at great length here, because most artesian waters in North Dakota are too heavily charged with mineral matter to be used for drinking or for domestic purposes. When an artesian well with good water is found, it should be carefully protected at the top like other bored or driven wells.

Cisterns

Certain districts of the state depend upon cisterns for the storing of rain water which can be used for domestic purposes. If the water is to be used it is essential to have the cistern constructed so that it is water-tight. This can be best done by using concrete. The inlet should be very carefully placed so as to insure against any leaks at this point. For the same reasons care must be exercised in locating and constructing the outlet. The manhole opening should be so placed that there is no possibility for the entrance of surface drainage. This can best be accomplished by constructing the walls of the opening of concrete making it continuous with the roof and extending from six to twelve inches above the surface of the surrounding ground. If the cistern is properly constructed and maintained water-tight the supply still may be of unsatisfactory quality due to pollution which may be washed from the roof or collecting area. Dirt, leaves and dropping from birds will make the water unsatisfactory if allowed to discharge into the cistern. The first wash from the roof should not be permitted to discharge into the cistern. After the roof is washed clean the water can be safely used. Cisterns should be cleaned and disinfected regularly in order to maintain the water in good condition. Generally it may be stated cisterns are not constructed as suggested above and many, in fact the greatest majority, do not provide a satisfactory supply. The water is nearly always highly colored, has an objectionable taste and odor and is more dangerously contaminated by leakage or the entrance of surface water. Cisterns should not be depended upon for drinking water supplies unless it is impossible to secure satisfactory springs or wells, and then only when properly constructed and protected.

Springs

In many parts of the countryy, springs commonly furnish pure and wholesome drinking water, but that is not always the case in North Dakota. Here most of the spring waters contain as much mineral matter as is found in well water. Many springs are so heavily charved with mineral salts that their waters are objectionable for constant use in the home.

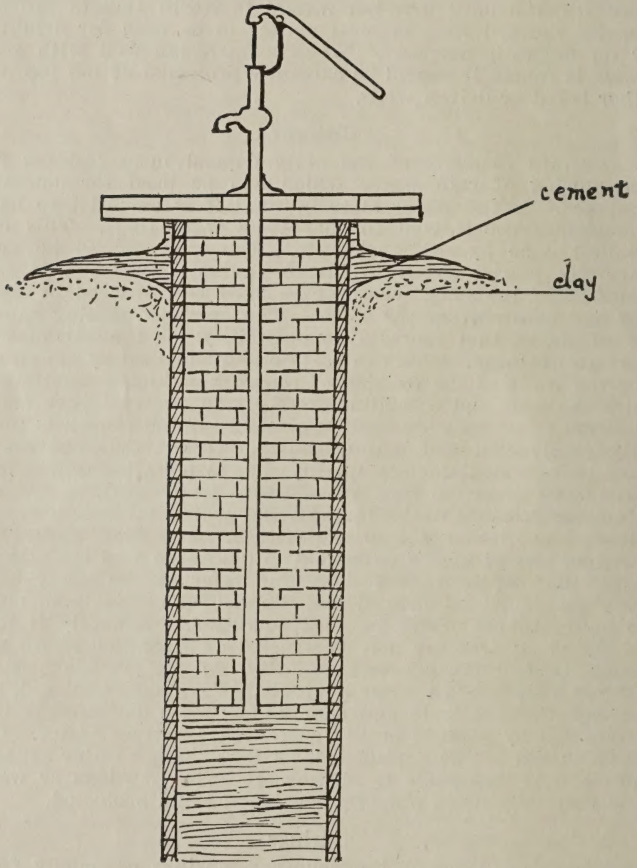


Figure 2.—This shows the common way in which wells of all dephts are polluted. Great depth is no safeguard against pollution of a well that is so poorly protected at the top. Filth falls directly into it through cracks in the top, and is washed in through defects in the upper part of the casing.

Samples of spring water have been received in this laboratory for analysis which were found to contain more than 200 grains of mineral water to the gallon (3285 parts per million), which is excessive. Some springs in North Dakota contain very good water from the sanitary point of view, but it is rather hard in all instances.

Contrary to the general belief, springs are as much subjected to pollution with filth and disease germs as are shallow wells. The only difference that there is, lies in the fact that springs are more often situated at a greater distance from outhouses, cess-pools, barn yards and other similar sources of pollution. These sources of pollution should never be tolerated within several hundred yards of a spring if the water from it is to be used for drinking purposes.

It is always wise to protect the outlet of the spring with masonry, which should be so cnostructed that it prevents surface washings from running into the spring in times of heavy rains.

Surface-Water

Many communities in North Dakota are obliged to take their water supply from rivers and small streams, because wells do not give an adequate supply, or because the water in them contains too much mineral salt for constant use. Every river in the state is heavily polluted with sewage and washings from barn yards, rendering these waters absolutely unsafe for drinking unless they are carefully purified by filtration.

How Typhoid Germs Get Into River Water and Lake Water.

We know that the germs of typhoid fever are given off from the patient's body with the dischargs from the bowels and kidneys. It has also been found during the last decade that there are persons,, apparently in good health, whose bowel and kidney discharges constantly contain large numbers of typhoid germs. The excreta from these "typhoid germ carriers" and from the patients usually go into the sewage, or are thrown out upon the banks of a river, and soon get into the running water. No water normally contains typhoid germs, but they occur there only when the water contains human excreta. If the water which is thus poisoned is used for drinking purposes by other communities many of those using it contract the disease.

Very extensive epidemics of typhoid fever have resulted from the use of water that had been polluted in this manner. We need only refer to the epidemic that occurred in Grand Forks in the fall of 1893, to illustrate this point. At that time Red Lake river water was used in Grand Forks without being filtered. This water was polluted at Crookston, Minn., and the result was that about 1,200 persons contracted the disease, and at least 125 patients died in the course of several months. Similar epidemics have occurred at Plymouth, Pa., in 1885, at Butler, Pa., Ithaca, N. Y., Ashland, Wis., and in Minneapolis, Minn., and Montreal, Canada.

How To Prevent Water-Borne Epidemics of Typhoid Fever.

Practically all extensive water-borne epidemics of typhoid fever are caused by the use of polluted surface-water. They can be prevented in one of several ways. In th first place no inland body of water or river should be polluted with raw sewage if the water is to be used untreated for a domestic supply by another community. It is practicable in many localities to dispose of sewage on land, where the disease germs are rapidly destroyed. Where this is not practicable, the sewage should be purified in some way before it is allowed to run into a river or lake. This can be done quite satisfactorily by means of a septic tank combined with a "sprinkling" or "trickling" filter, with an intermittent sand filter or activated sludge method. The septic tank alone is usually not sufficient to give it a sanitary effluent. With the use of hypochlorite of lime it seems, however, that the effluent from a septic tank can be rendered sterile with a very small expenditure for chemicals.

Some of these methods of sewage purification need to be further tested before we can say just what they will do in North Dakota during the cold winter weather. The state should make a small appropriation to have an investigation made under the direction of the State Health Laboratories.

The Purification of Drinking Water

There is a wide-spread belief that polluted river water purifies itself during a flow of eight to ten miles. This belief is based upon the fact that the polluting matter can no longer be seen by the naked eye after it has been thoroughly mixed with a large volume of water. Since the introduction of careful bacteriological and chemical analyses of water it has been found that polluted water does not undergo as rapid self-purification as was formerly supposed. During the last few years the Public Health Laboratory has made a careful study of the self-purification of the water in Red Lake river. This study has shown that there is very little self-purification of this water, during the winter months, from the time it is polluted at Crookston, Minn., until it reaches Grand Forks, N. D. During the summer months there is a much greater purification of the water during this flow of about ninety miles, but sewage bacteria (colon bacilli) are always present in it when it reaches Grand Forks. Typhoid bacilli when put in a dialyser and floated from Crookston to Grand Forks are by no means all dead at the end of the journey, which takes two days. It is evident, therefore, that not much reliance should be placed on the self-purification of sewage polluted streams if the water is to be used for drinking purposes.

Whenever river or lake water that has been polluted with sewage is to be used for drinking water it should be purified by filtration through sand and then sterilized. There are two main types of sand filters, known as the slow sand filters and the rapid or mechanical filters. Both of these give good results when properly operated. The mechanical filters are less costly, and are better adapted to the purification of turbid waters, such as we have in North Dakota.

A few words must be said about the various household filters. The majority of these are worse than nothing because they do not remove any of the bacteria but, on the contrary, furnish a culture medium in which the bacteria can multiply. The Berkefeld filters and the Chamberland-Pasteur filters may do effective service, but they must be thoroughly cleaned and boiled every two to three days. If this is neglected, filth collects on them which is a culture medium for the bacteria to grow in.

Various chemicals have been used to sterilize waters, but most of them have not given satisfactory results. Most of these chemicals are poisonous and if enough is added to the water to kill all bacteria there is some danger of getting the effects of poison. For the past few years hypochlorite of lime has been used with good success. This substance should not, however, be used by the inexperienced. More recently liquid chlorine has taken its place, altogether due to its higher efficiency and more accurate dosage.

Whenever there is a suspicion that the water is polluted, it should be boiled before it is used for drinking. This kills the dangerous bacteria and does not harm the water. The "flat" taste of boiled water can be greatly improved by pouring it through the air a number of times, from one vessel into another, after it has been allowed to cool.

Water Analysis

There is no simple test that can be applied by anyone but an expert to determine whether or not a given water is safe. An inspection of the premises about a well or spring is of great value. If river water is used, it is practically certain that it is polluted because there is hardly a river in North Dakota that does not receive raw sewage. Those that are not polluted in this way get more or less drainings from barnyards and outhouses, which renders them unsafe.

The Public Health Laboratory makes bacteriological analyses of water free of charge. A chemical analysis should also be made when it is desired to know whether or not a water is safe and suitable for constant use in the home, a small fee is charged for this.

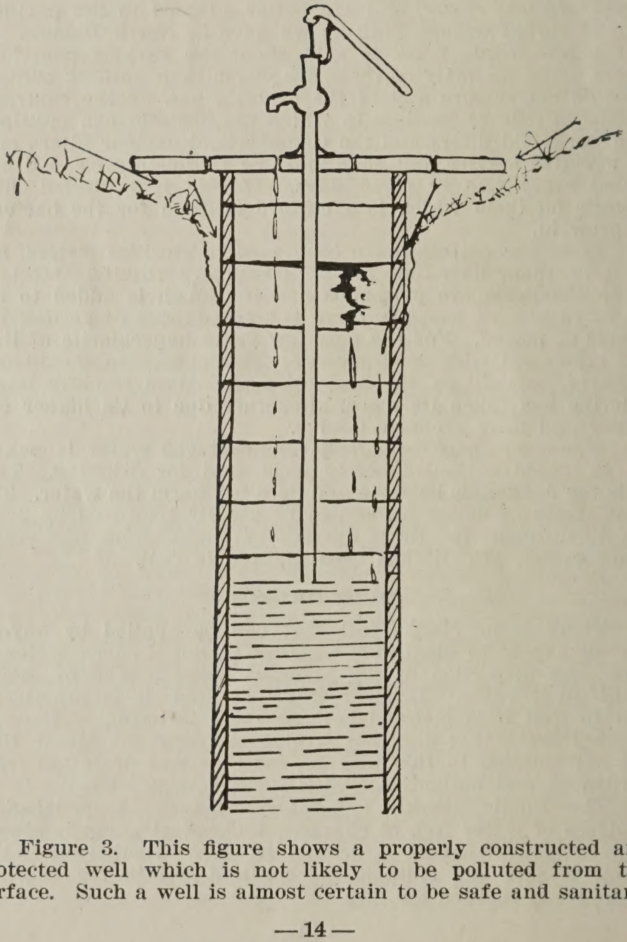


Figure 3. This figure shows a properly constructed and protected well which is not likely to be polluted from the surface. Such a well is almost certain to be safe and sanitary.

Water submitted for analysis must be sent in our special conveyors, packed in ice. It is very essential that the water should be sent in absolutely clean and sterile bottles and be kept cold during transit. If these precautions are not taken, the analysis cannot be reliable and might as well not be made.

When an analysis is desired please write to the Public Health Laboratory for a conveyor, which will be sent to you by express. Transportation charges must be paid by the party sending the water.

The State Public Health Laboratories, realizing that the situation as regards a safe and wholesome water supply is acute in certain parts of our state, stands ready to aid the individual farmer, the small town or city to solve the local water problem. Cities contemplating new water supplies, sedimentation, coagulation, filtration or water softning plants, can always feel free to ask for expert aid and advice.

Since January 1920 the State Board of Health requires all cities, towns, and villages which intend installing water systems to submit plans for the same to the Division of Sanitation of these laboratories for approval, further, the sources of supply have also to be approved as regards their suitability for drinking, cooking and laundry purposes.

To further safeguard the citizens of the State and others, all water supplied by the railroads for drinking and washing purposes on passenger and sleeping cars is examined, bacteriologically, twice a year and the source is inspected once a year. When one is not sure as to the purity of the water, or has received a report that the water is not safe, it is possible to render it so by the use of calcium hypochlorite tablets, "Halozone" it is called, which can be obtained from any good druggist. Full directions for their use are on every bottle and should be followed closely.

The standards set for a pure water from a bacteriological standpoint in this State are those adopted by the United States Public Health Service namely:

100 or less colonies of bacteria per cubic centimeter or quarter teaspoonful of water, and the production of no gas due to sewage organisms in 50 cubic centimeters or one and one half ounces of the suspected water.

So many chemical analyses have been made by these Laboratories and such a thorough examination of the State has been made by the State Geological Survey that application to either of these departments at University, N. Dak., will bring information as to the possible success in obtaining a satisfactory water when searching for the same in any part of the State.

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FREE BULLETIN FOR CITIZENS

1. State Public Health Laboratory. History, Instructions and Fee table.
*2. What You Should Know About Tuberculosis.
3. Pure Water and How to Obtain It.
*4. Sporotrichoisis in North Dakota.
*5. Facts about Rabies.
6. The Production and Care of Milk for Infant Feeding.
7. Facts about Cancer.
8. The Fly; a disease carrier.
9. Ninth Annual Report of State Public Health Laboratories.
10. The Sanitary Privy.
11. Your Baby, How to Keep it Well.
12. The Next Step towards Efficiency in Public Health.
13. Fresh Air and Why. A talk on school room ventilation
14. Colds. Cause, prevention and home treatment.
15. Cerebro spinal meningitis.
16. Keeping in Repair. How to care for the body—Physical examinations.
17. Scarlet Fever. How it may be detected. How it may be avoided. Directions to mothers, nurses, physicians and health officers for treating cases of this disease.
20. Diphtheria. Cause, prevention and cure.
21. Typhoid Fever. Information for those who care for patient, for physician and health officers in regard to the spread and prevention of typhoid fever.
22. Measles and Whooping Cough. Information for parents and for those who care for the patient, for physicians and health officers in regard to spread and prevention of measles and whooping cough.
23. Smallpox. How to detect this loathsome disease. How the disease spreads, and how it may be avoided. Direction for care of patients.
24. The Wasserman Reaction as a diagnostic procedure. Interpretation. Need for a history. Provocative Wasserman.
25. Health Officer's Loan Library.
26. Stereoptican Loan Library.
*27. Rural Home Comforts. A series of four blue prints together with specifications dealing with the subject of septic tank and sewage disposal.
28. Influenza.
29. First Biennial Report of Public Health Laboratories.
30. Second Biennial Report of Public Health Laboratories.

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* Not in print.